AD-A083 425 COAST GUARD RESEARCH AND DEVELOPMENT CENTER GROTON CT F/G 13/10
MARINE TRAFFIC DATA OF LOWER PUGET SOUND.(U)
APR 80 J J CHERNY, R A SILVA, M R YOUNG
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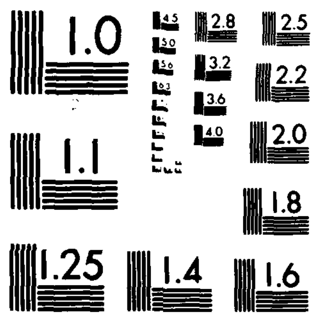


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

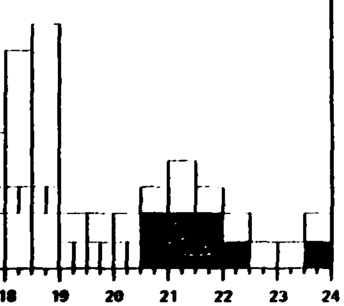
RADAR VESSEL DENSITY DATA

t of Puget Sound

dar Site: Saltwater State Park

e: 18 October 1978

y: Wednesday



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16. Abstract

Data was collected on the marine traffic at lower Puget Sound, Washington, during the period of 15-22 October 1978. The marine traffic data was recorded by means of time-lapse photography of a radar display.

The daily average of marine traffic, including large, medium, and small vessels, and tugs-in-tow, transiting Puget Sound between Point Pully and Tacoma Harbor is 27.

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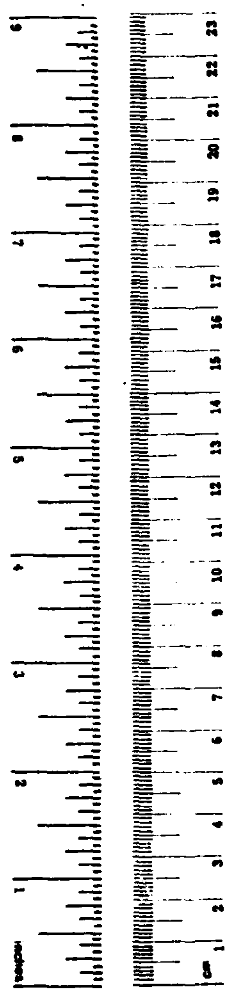
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

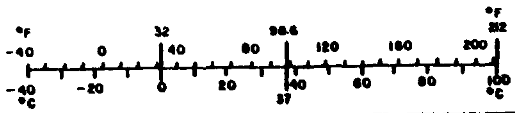
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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LIST OF ILLUSTRATIONS

1.0 INTRODUCTION

This report documents the data obtained on the marine traffic at Puget Sound, Seattle, Washington (Figure 1-1), by U.S. Coast Guard Research and Development Center (R&DC) personnel, using the Center's vessel traffic services data collection trailer during the period of 15 to 22 October 1978. The data consists of film recordings of a radar display, the details of the procedure for recording and analyzing the data being presented in later paragraphs.

The data was obtained to establish the approximate amount of marine traffic presently transiting the lower Puget Sound area. The data was collected at the request of Commandant (G-DOE), USCG, as part of the Puget Sound Vessel Traffic Services and radar surveillance expansion.

In an attempt to mitigate the risks of vessel accidents in Puget Sound, the U.S. Coast Guard established the Puget Sound Vessel Traffic System, now the Puget Sound Vessel Traffic Service (PSVTS), in September 1972. Phase I (1972) established (1) a buoyed Traffic Separation Scheme (TSS) (commonly referred to as traffic lanes) in the eastern Strait of Juan de Fuca, Rosario Strait, Admiralty Inlet, and Puget Sound south to Tacoma; and (2) a Vessel Movement Reporting System (VMRS) conducted via VHF-FM radio-telephone communications from a Vessel Traffic Center (VTC) at Pier 90 in Seattle.

In 1974, the communications-based VMRS was augmented with limited radar surveillance of congested areas (Phase II). Radar surveillance from Admiralty Inlet to Seattle was implemented in October 1975. A new VTC was established at the U.S. Coast Guard Support Center at Pier 36 in Seattle to accommodate the expanded system. Presently, the PSVTS consists of a TSS, a VMRS (which incorporates a VHF-FM Communications System to monitor shipping in the PSVTS area), and a limited Radar Surveillance System, all coordinated through the VTC.

The U.S. Coast Guard proposes to improve the existing PSVTS by: (1) expanding the radar surveillance system to include the Strait of Juan de Fuca, the southern portion of the Strait of Georgia, Rosario Strait, Admiralty Inlet, and Puget Sound south to northern Vashon Island; and (2) upgrading and augmenting the existing radar surveillance system in Puget Sound. These improvements will be designed to be compatible with stated U.S./Canadian plans for joint control as well as to permit future expansion of radar surveillance into south Puget Sound. These improvements constitute Phase III of the PSVTS. The proposed radar surveillance system will consist of ten radar sites, compared to four existing sites. Three of the existing sites, Point No Point, Point Wilson, and Pier 36 will be upgraded with high performance radar. High performance radar will be installed at seven new sites. One existing site, Bush Point, will be deactivated.

Three new remote radar sites (Cape Flattery, Pearson Creek, and Port Angeles) will be established to expand radar surveillance to the Strait of Juan de Fuca. Three additional remote sites (Smith Island, Shannon Point, and Village Point) will be established to permit radar surveillance of Rosario and Georgia Straits. New remote radar installations will be constructed near the existing remote sites at Point Wilson and Point No Point, which will be augmented by a new radar facility at West Point in Seattle. The combination of these three facilities will provide radar coverage of Admiralty Inlet and the Puget Sound south to Elliott Bay. Figure 1-2 indicates the existing and proposed radar sites for the PSVTS.

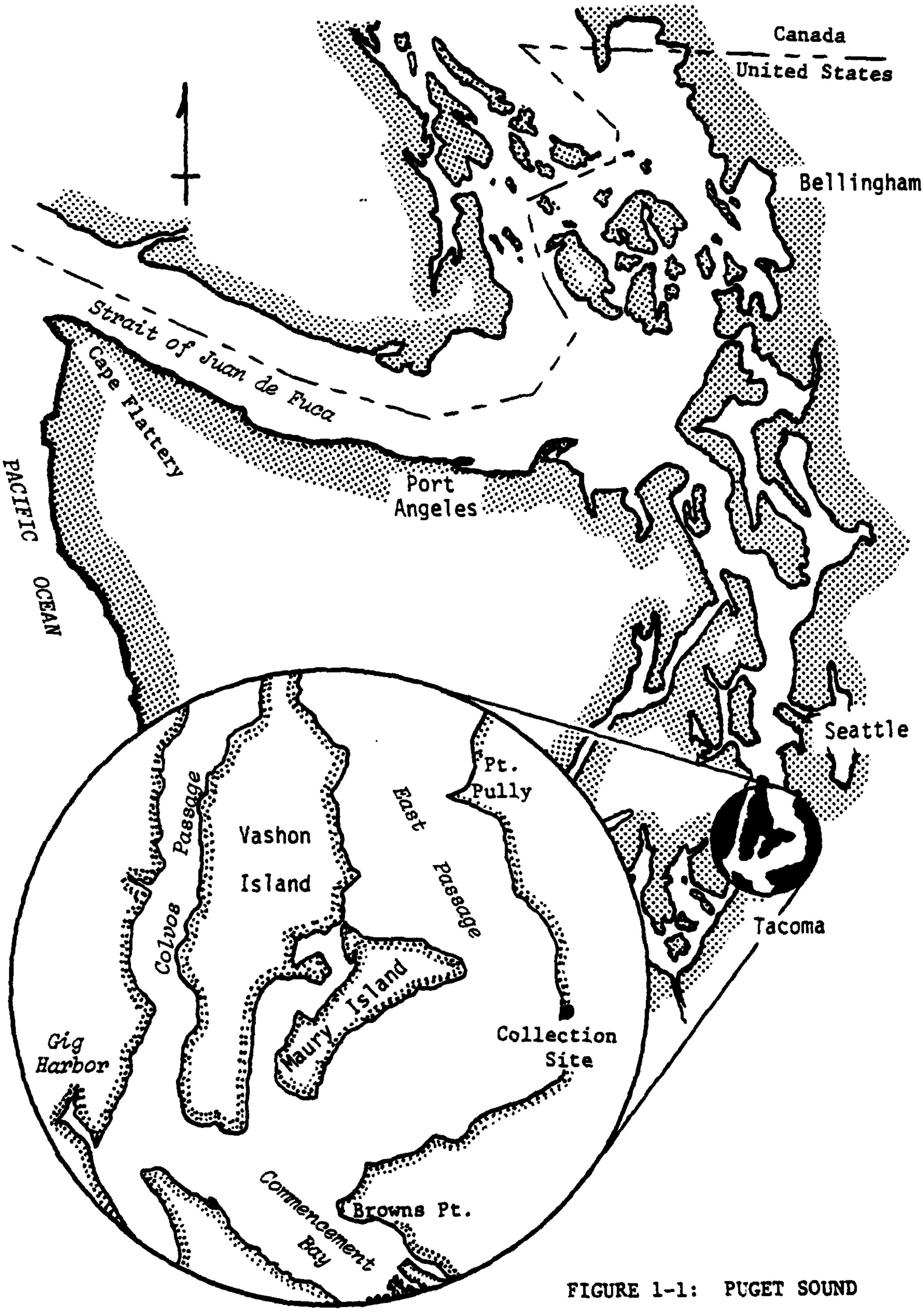


FIGURE 1-1: PUGET SOUND

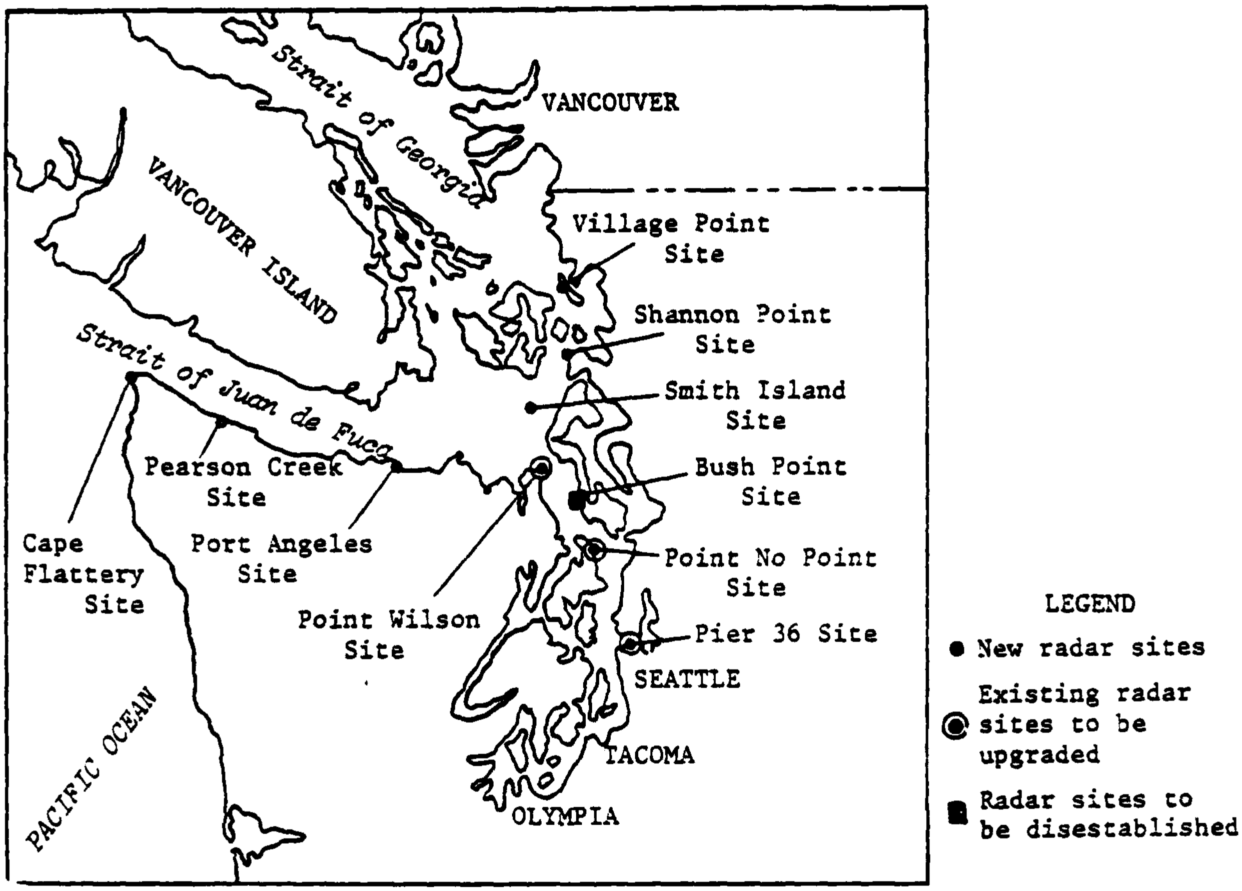


FIGURE 1-2: PUGET SOUND VESSEL TRAFFIC SERVICE EXISTING AND PROPOSED RADAR SITES

1.1 Site Selection

In order to obtain the best coverage of the marine traffic transiting the lower Puget Sound, it was decided that the site that would afford the most (and most useful) data was Saltwater State Park at Des Moines, Washington, position 42°22'25"N, 122°19'45"W. The radar antenna, mounted on the roof of the data collection trailer, was approximately 15 feet above sea level. From this site, all traffic transiting Puget Sound between Point Pully and Robinson Point and Tacoma Harbor passed through the radar coverage area. Colvos passage was not observed during the data collection.

1.2 Radar Data Collection Procedures

The R&DC data collection radar and associated equipment are mounted in a specially built trailer for ease of transportation, use, and protection from the elements.

The radar used for data collection is a Decca Marine Model RM429 which operates in the frequency band of 9380 to 9440 MHz. The radar antenna has a horizontal beamwidth of 0.8 degrees at the -3 decibel points and the radar transmitter pulse length varies from 0.05 microseconds to 1.2 microseconds, depending on the range selected. A 16mm motion picture camera is mounted over the radar Plan Position Indicator (PPI) display and focused so that the PPI presentation fills the majority of the 16mm film area. (A hood is used to screen out ambient light.) The camera is operated in the single-frame, time-lapse mode with the shutter of the camera controlled by a solenoid. The solenoid is activated by the radar heading flasher switch so that the shutter is held open for one complete revolution of the radar antenna, then closed for the second revolution, open for the third revolution, and so on. As a result of this procedure, the film consists of "snapshots" of the entire sweep of the radar, which is more pleasing to the eye and easier to interpret than a conventional motion picture.

Mounted above and below the PPI display, and within the field of view of the camera, are small, alpha-numeric display panels. Auxiliary circuitry is used to display, on these panels, the date and time and geographic name of the radar site. As a result, each frame of the 16mm film contains the time it was exposed and the location of the radar at that time. This information simplifies the task of determining vessel speeds or the time an observed event occurred.

The radar has the capability for orienting the PPI display to any direction. The display is set up with true North at the top of the 16mm film frame when viewed so that the alpha-numeric characters are properly oriented. However, due to various limitations, the orientation of the film image with respect to true North is probably not accurate to better than ± 5 degrees.

The radar has also the capability of offsetting the antenna location from the center of the PPI display. This capability allows the PPI display to be oriented so that a particular area of interest fills a greater portion of the 16mm film frame than would otherwise be possible.

Although the radar is equipped with the usual heading flasher, fixed and variable range rings, and bearing cursor, they are usually suppressed and do not appear on the film imagery.

After the radar data collection trailer is located at a given site, tested and adjusted, data is usually recorded on a 24-hour-a-day basis for seven days, with a frame of film being exposed approximately every five seconds during this period. However, a few minutes of data are lost every five hours when the film is changed. Radar data from 1200, 15 October 1978 to 1745, 16 October 1978, is not available because of equipment failure.

2.0 DISCUSSION OF DATA

The information contained in this chapter was collected at the lower Puget Sound, Des Moines (Seattle), Washington, during the period of 15-22 October 1978. The radar was operated on the 12.0 nautical mile scale. Figure 2-1 indicates the area of radar coverage.

RADAR SHADOW

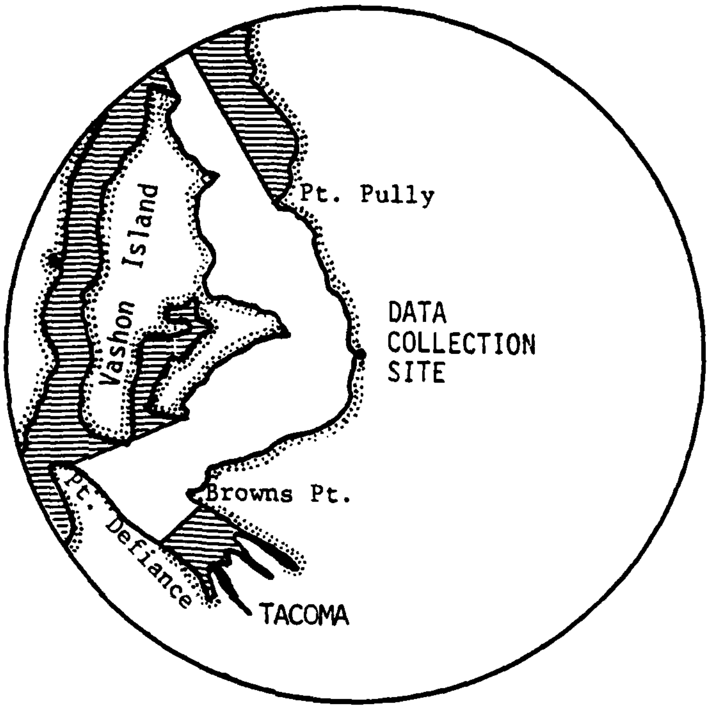


FIGURE 2-1: AREA OF RADAR COVERAGE (12 NAUTICAL MILE RADIUS)

2.1 Vessel Activity

In general, the following information can be extracted from the time-lapse radar film:

1. Vessel density
2. Vessel speed
3. Destination
4. Anchorage locations
5. Closest point of approach (CPA) to other vessels
6. Number and time of occurrence of meeting situations
7. Number and time of occurrence of crossing situations
8. Number and time of occurrence of overtaking situations

The vessel density within the radar coverage area is presented in Figures 2-2 through 2-8. Vessel density is defined as the count of all vessels present within the radar coverage area, taken at 30-minute intervals. The interval between counts was chosen to be equal to or less than the average vessel transit time through the radar coverage area. The vessels counted were classified by type and size, such as large (larger than 300 feet), medium, small (less than 100 feet), tug-in-tow, etc.,

determination of size being evaluated from the size relationship of the radar image. The "small" category includes fishing vessels, pleasure craft, and tugs that were not recognized as such. The data is presented as a histogram with time of day as the abscissa.

The maximum number of simultaneous movements observed at the lower Puget Sound was 16, occurring at 1645 on Saturday, 21 October 1978. This number represents the presence of a regatta containing 16 sail pleasure craft. The maximum number of simultaneous movements observed utilizing the Traffic Separation Scheme was 8, occurring at 1845 on Wednesday, 18 October 1978. This number represents the presence of 2 large and 6 small vessels.

The average of daily vessel transits, by classification and direction, is as follows:

VESSEL SIZE	NORTHBOUND	SOUTHBOUND
Large	4	4
Medium	3	4
Small	6	5
Tug-in-tow	0	1

The following meeting and overtaking situations between large and medium vessels were observed during the data collection period:

MEETING	OVERTAKING
1	3

An encounter between two medium or large vessels is deemed a "close encounter" if the distance between the vessels at their closest point of approach is less than 300 yards. There were no close encounters observed during the data collection period.

2.2 Vessel Speeds

The vessel speed data is based on the speeds of virtually all of the vessels imaged by the radar and is presented in Figures 2-10 through 2-16. A summary follows:

15 Oct - Sunday	——DATA NOT AVAILABLE——
16 Oct - Monday	3.0 - 13.0 knots (7.66 knots average)
17 Oct - Tuesday	3.0 - 15.0 knots (7.50 knots average)
18 Oct - Wednesday	5.0 - 15.0 knots (8.54 knots average)
19 Oct - Thursday	2.0 - 17.0 knots (8.02 knots average)
20 Oct - Friday	5.0 - 18.0 knots (8.30 knots average)
21 Oct - Saturday	6.0 - 22.0 knots (9.06 knots average)
22 Oct - Sunday	4.0 - 12.0 knots (7.87 knots average)

Vessel speeds are determined by noting the distance in hundreds of yards that the vessel travels in three minutes, then applying the three-minute rule for speed, which states that the distance (in hundreds of yards) a vessel travels in three minutes is its speed in knots. Example: if a vessel travels 2,350 yards in three minutes, its speed is 23.5 knots.

All vessel speed data is dependent upon two factors: time and distance. The time component is held constant at three minutes and is measured by reading directly from the radar film. Since the individual frames are separated by, at most, five seconds, the error limit for each time measurement is, at most, +/-1.4 percent. Also, in measuring the distance between two points, there is an error associated with the measurement resolution of the ruler used. Additionally, the radar returns are not always distinct and symmetrical, thus measurement to the center of the return involves some estimation.

2.3 Route Identification

A route identification of the marine traffic transiting the lower Puget Sound from 0000 to 2359 of Saturday, 21 October 1978, is presented in Figure 2-9. The tracks represent the transits of 5 large, 6 medium, and 2 small vessels.

2.4 Weather

Weather data, including the cloud coverage, wind direction and velocity, and visibility in nautical miles is collected every hour, on-the-hour.

The following visibilities were recorded:

6 nautical miles	=	30 percent
4-6 nautical miles	=	29 percent
1-3 nautical miles	=	31 percent
1 nautical mile	=	10 percent

The greatest period in which visibilities were recorded at less than one nautical mile occurred during the period of 1200 and 1800 on Tuesday, 18 October 1978, visibility being reduced because of fog. Visibility was also recorded at less than one nautical mile, because of fog, between 0300 and 0800 on Wednesday, 19 October 1978. Fog was present 45 percent of the data collection period, with fog and/or haze being recorded during 70 percent of this period.

The winds recorded at Saltwater State Park were primarily from the north or northwest, with 1 percent of the winds being 6 to 10 knots velocity, 10 percent being 1 to 5 knots velocity, and 89 percent being calm.

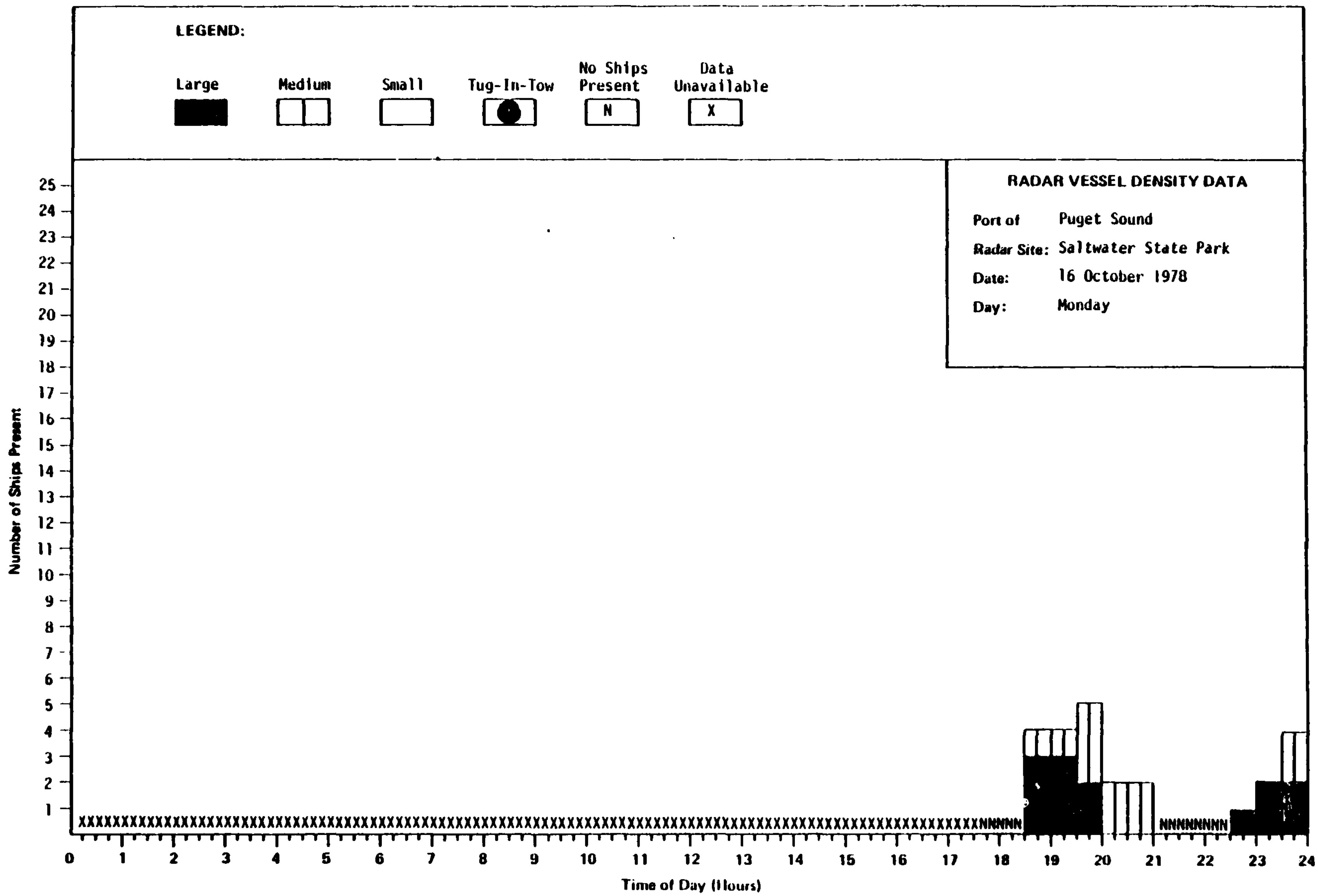

LEGEND:
Large
Medium
Small
Tug-In-Tow
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Puget Sound
Radar Site: Saltwater State Park
Date: 16 October 1978
Day: Monday
Number of Ships Present
Time of Day (Hours)

FIGURE 2-2

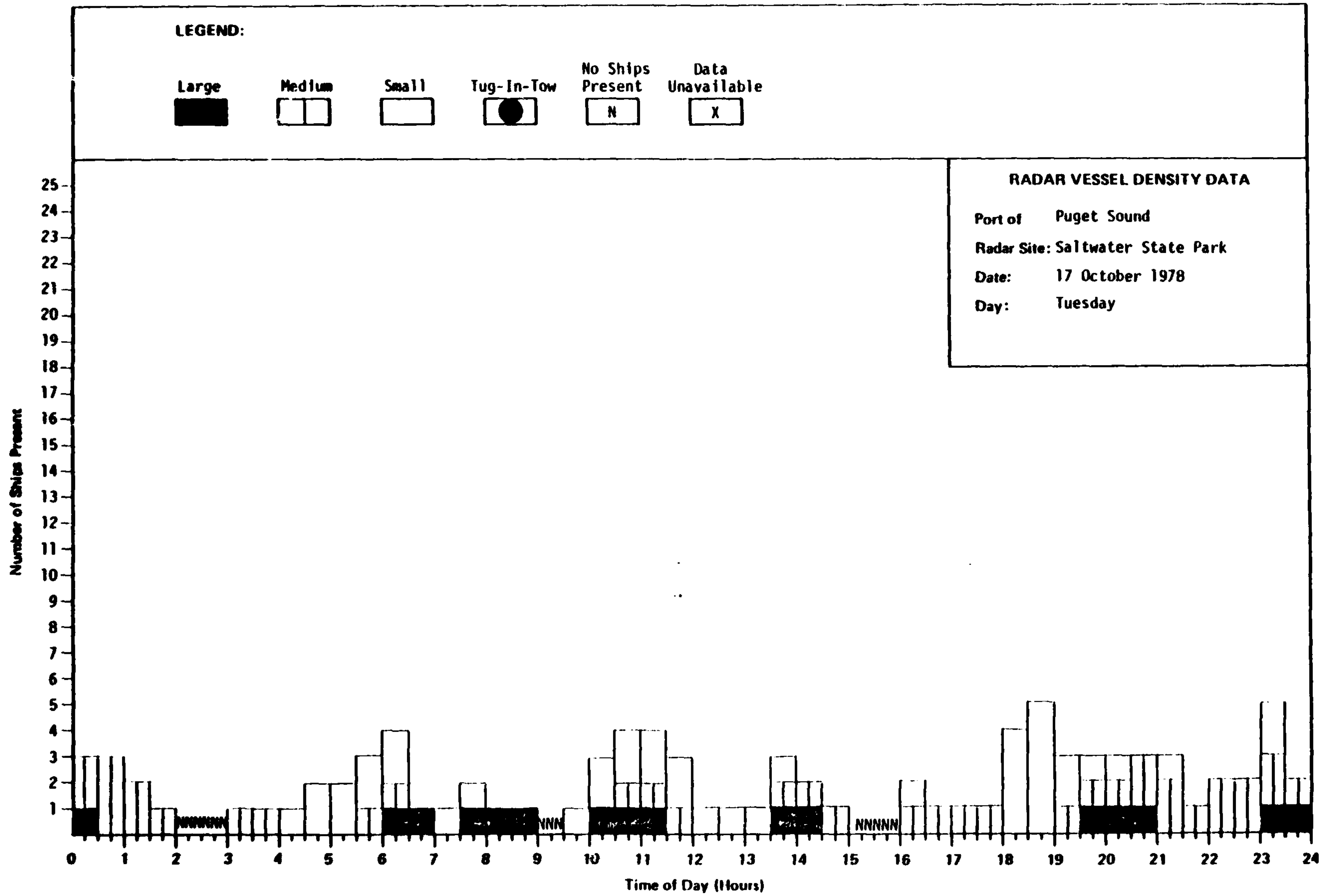
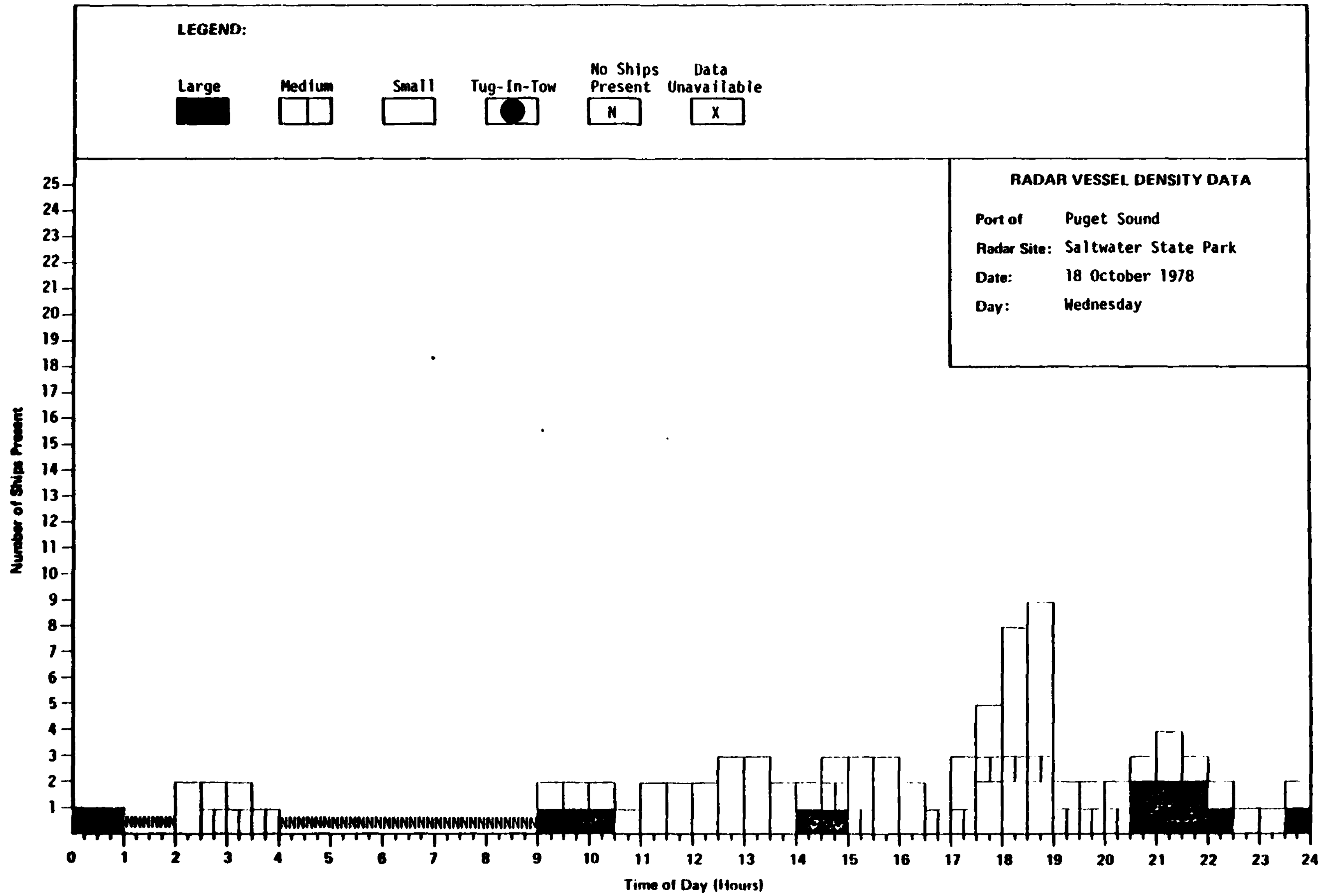

LEGEND:
Large
Medium
Small
Tug-In-Tow
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Puget Sound
Radar Site: Saltwater State Park
Date: 17 October 1978
Day: Tuesday
Number of Ships Present
Time of Day (Hours)

FIGURE 2-3



LEGEND:
Large
Medium
Small
Tug-In-Tow
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Puget Sound
Radar Site: Saltwater State Park
Date: 18 October 1978
Day: Wednesday
Number of Ships Present
Time of Day (Hours)

FIGURE 2-4

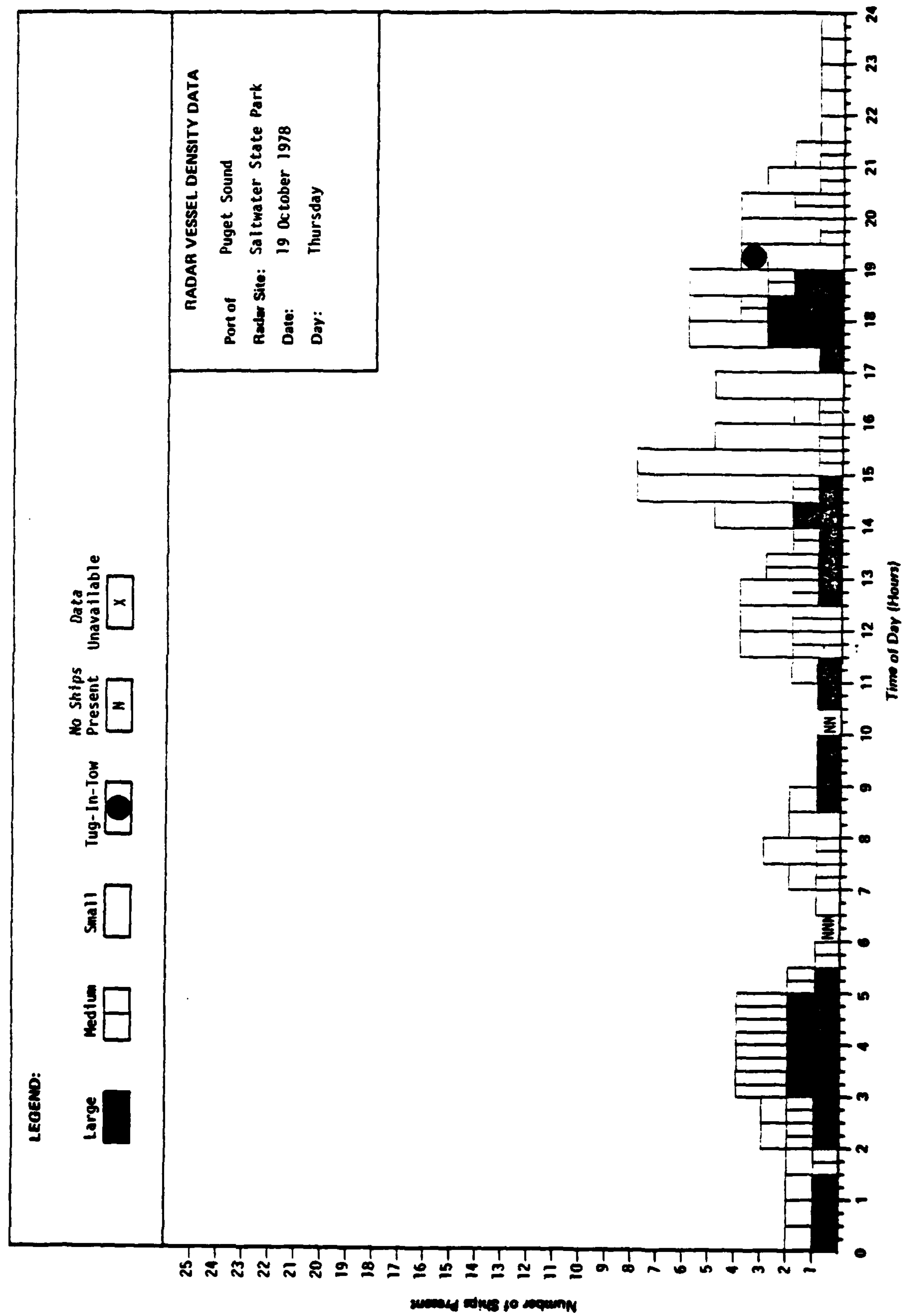

LEGEND:
Large
Medium
Small
Tug-In-Tow
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Puget Sound
Radar Site: Saltwater State Park
Date: 19 October 1978
Day: Thursday
Number of Ships Present
Time of Day (Hours)

FIGURE 2-5

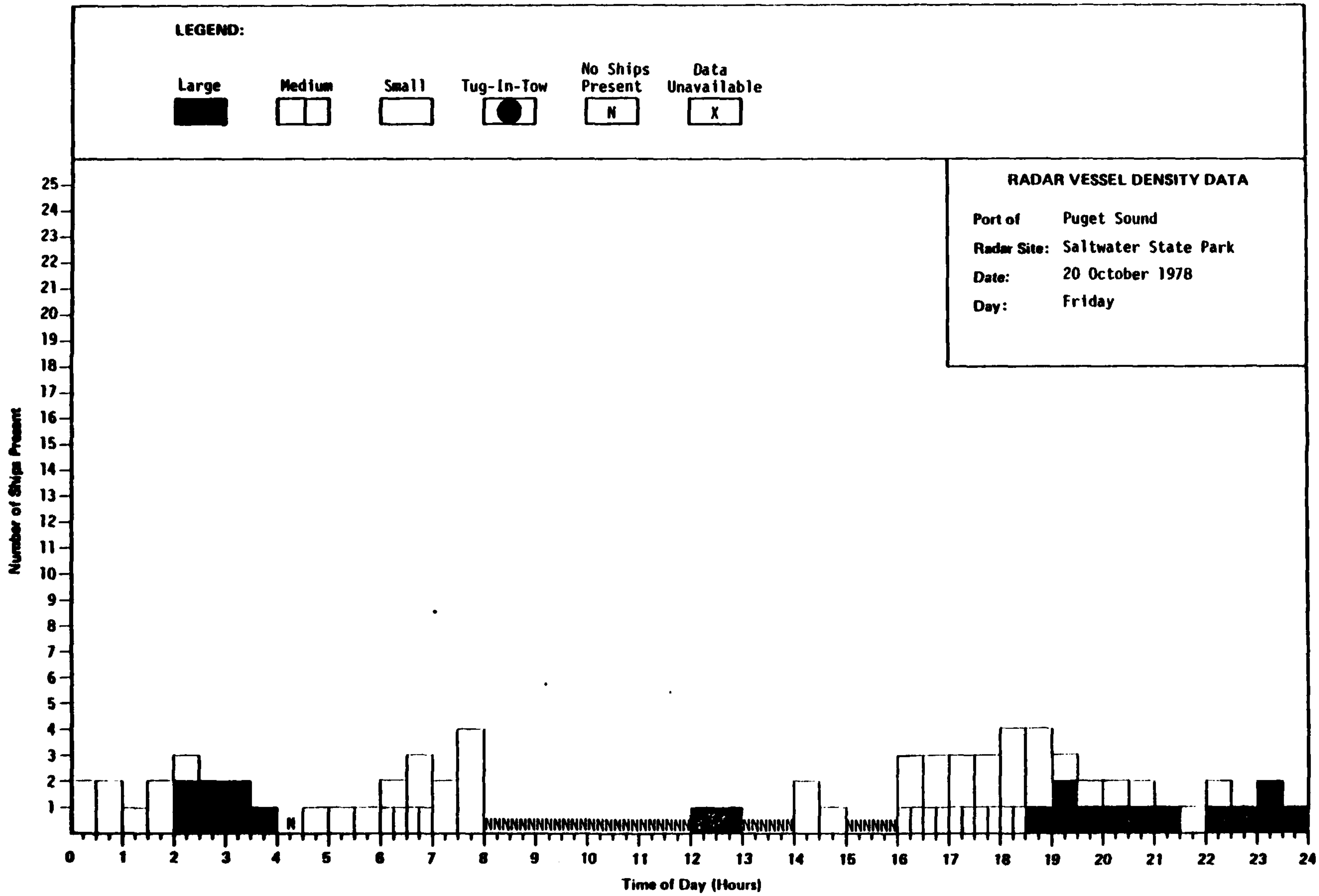

LEGEND:
Large
Medium
Small
Tug-In-Tow
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Puget Sound
Radar Site: Saltwater State Park
Date: 20 October 1978
Day: Friday
Number of Ships Present
Time of Day (Hours)

FIGURE 2-6

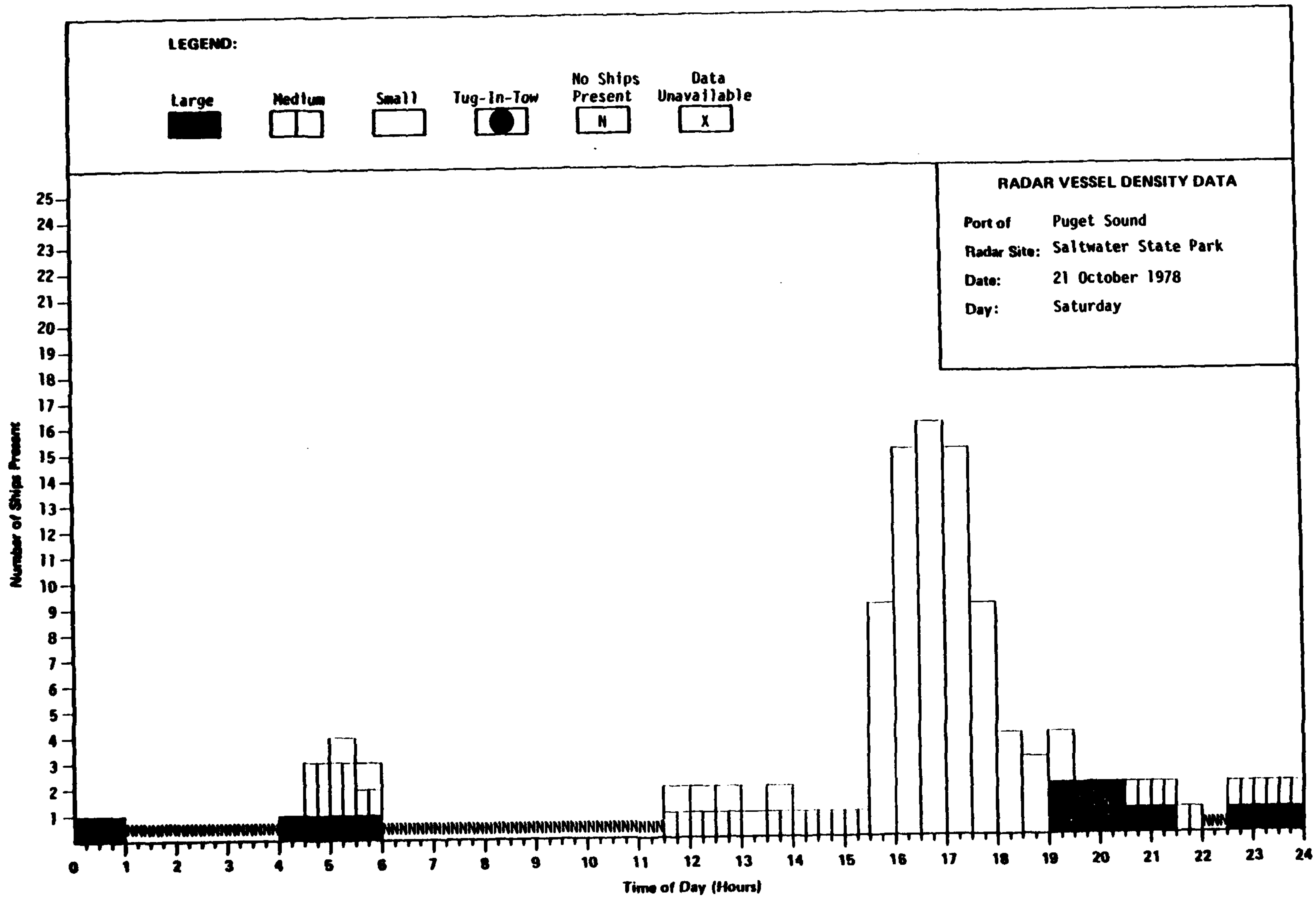
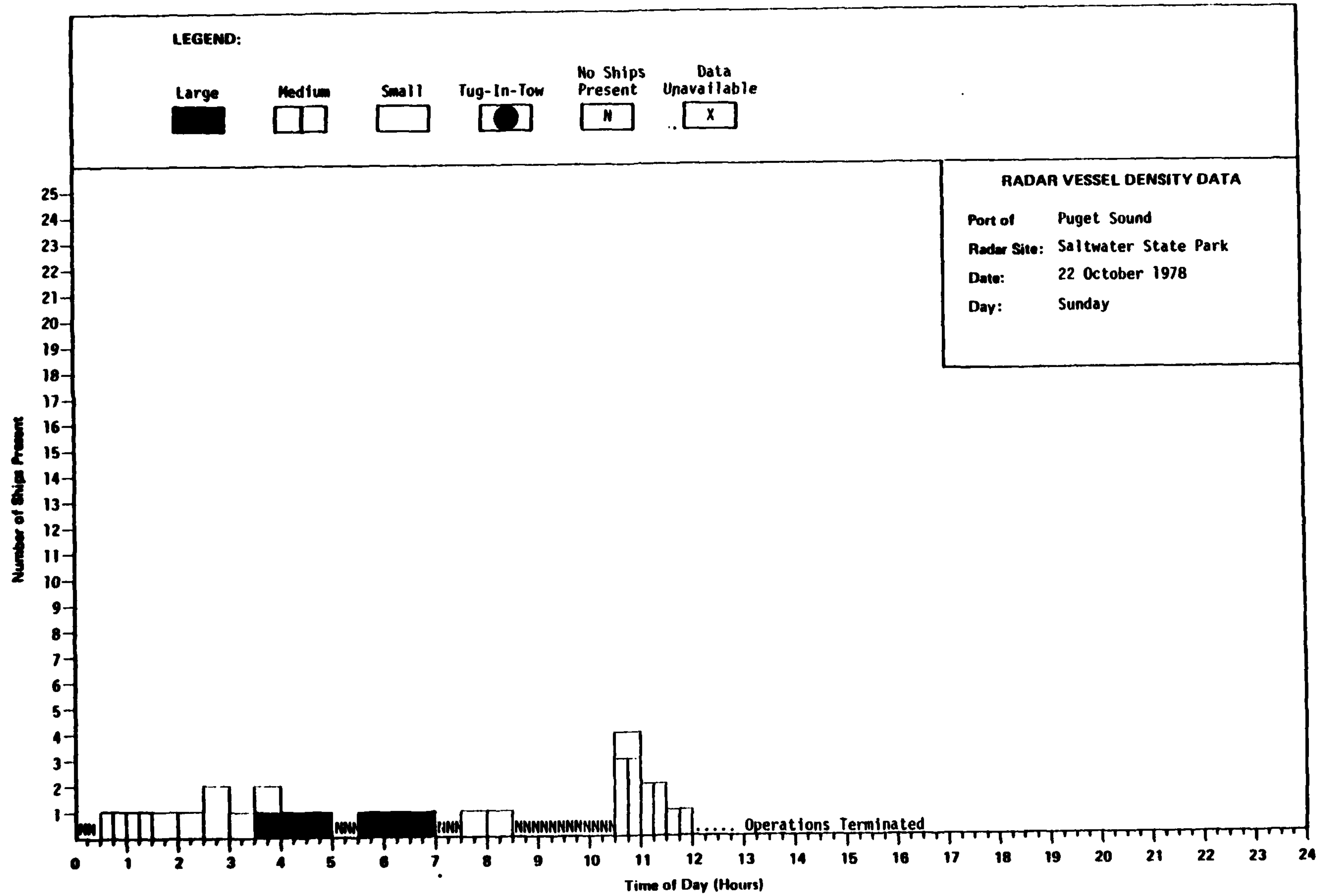

LEGEND:
Large
Medium
Small
Tug-In-Tow
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Puget Sound
Radar Site: Saltwater State Park
Date: 21 October 1978
Day: Saturday
Number of Ships Present
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day (Hours)

FIGURE 2-7



LEGEND:
Large
Medium
Small
Tug-In-Tow
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Puget Sound
Radar Site: Saltwater State Park
Date: 22 October 1978
Day: Sunday
Number of Ships Present
Time of Day (Hours)
Operations Terminated

FIGURE 2-8

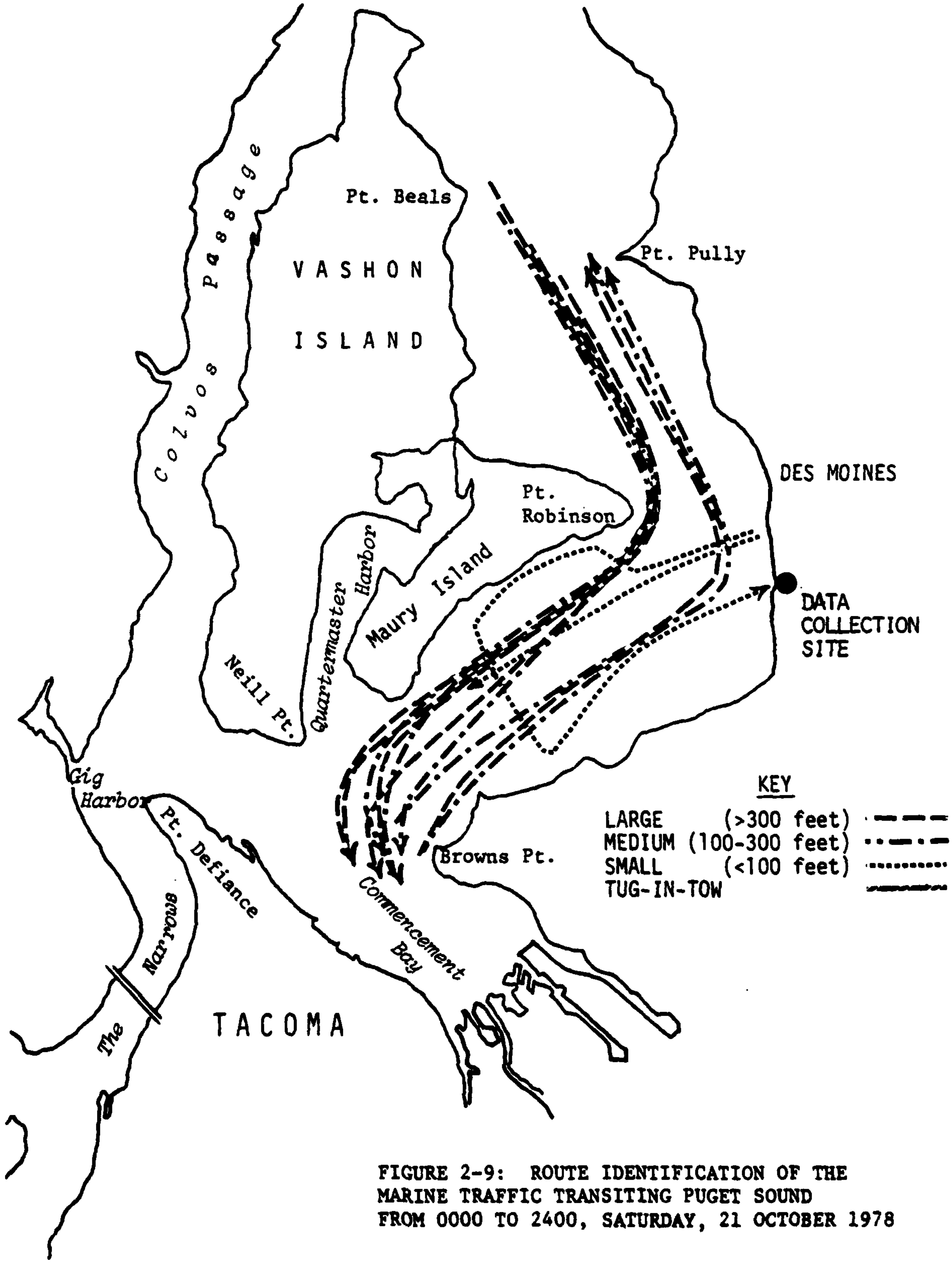


FIGURE 2-9: ROUTE IDENTIFICATION OF THE MARINE TRAFFIC TRANSITING PUGET SOUND FROM 0000 TO 2400, SATURDAY, 21 OCTOBER 1978

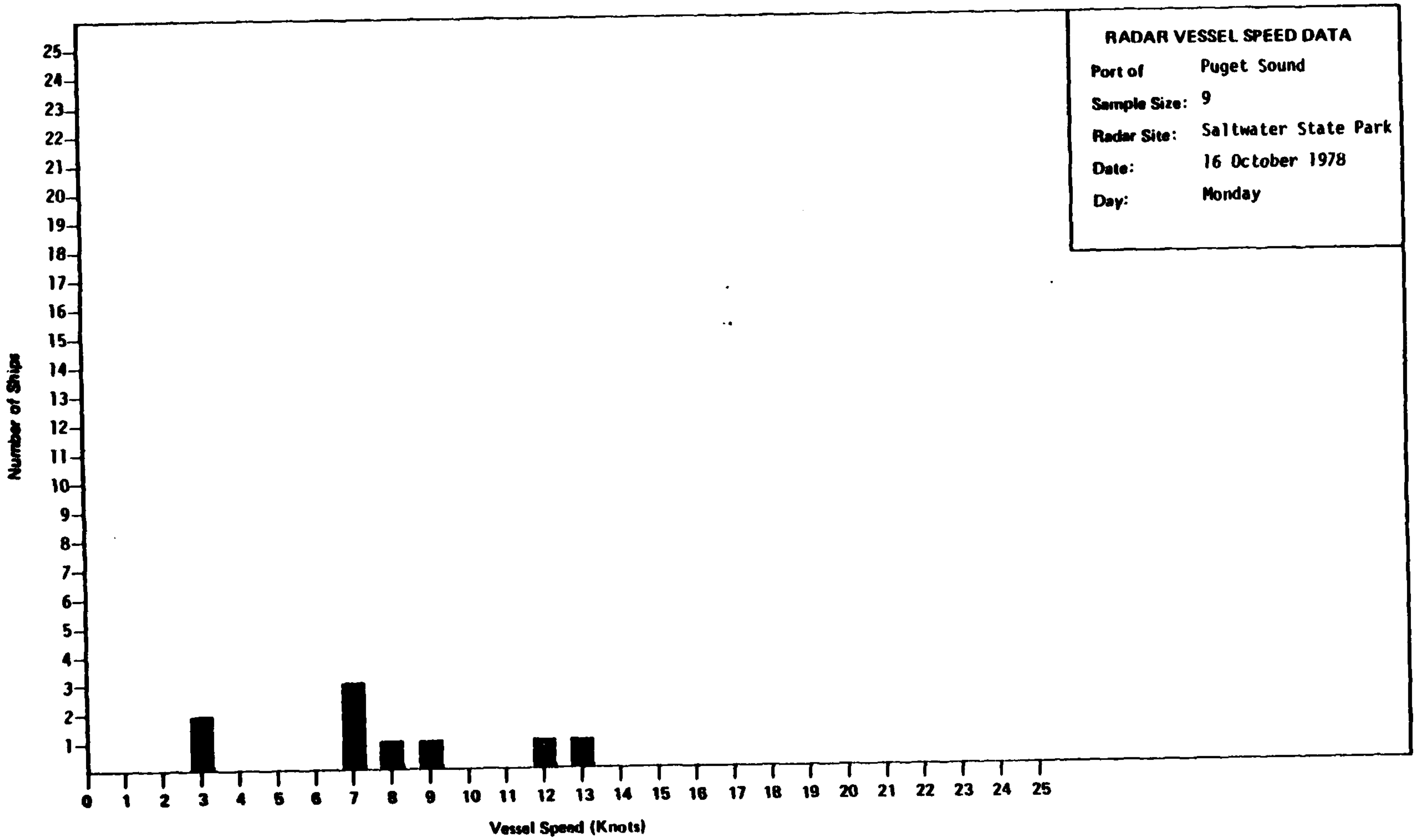
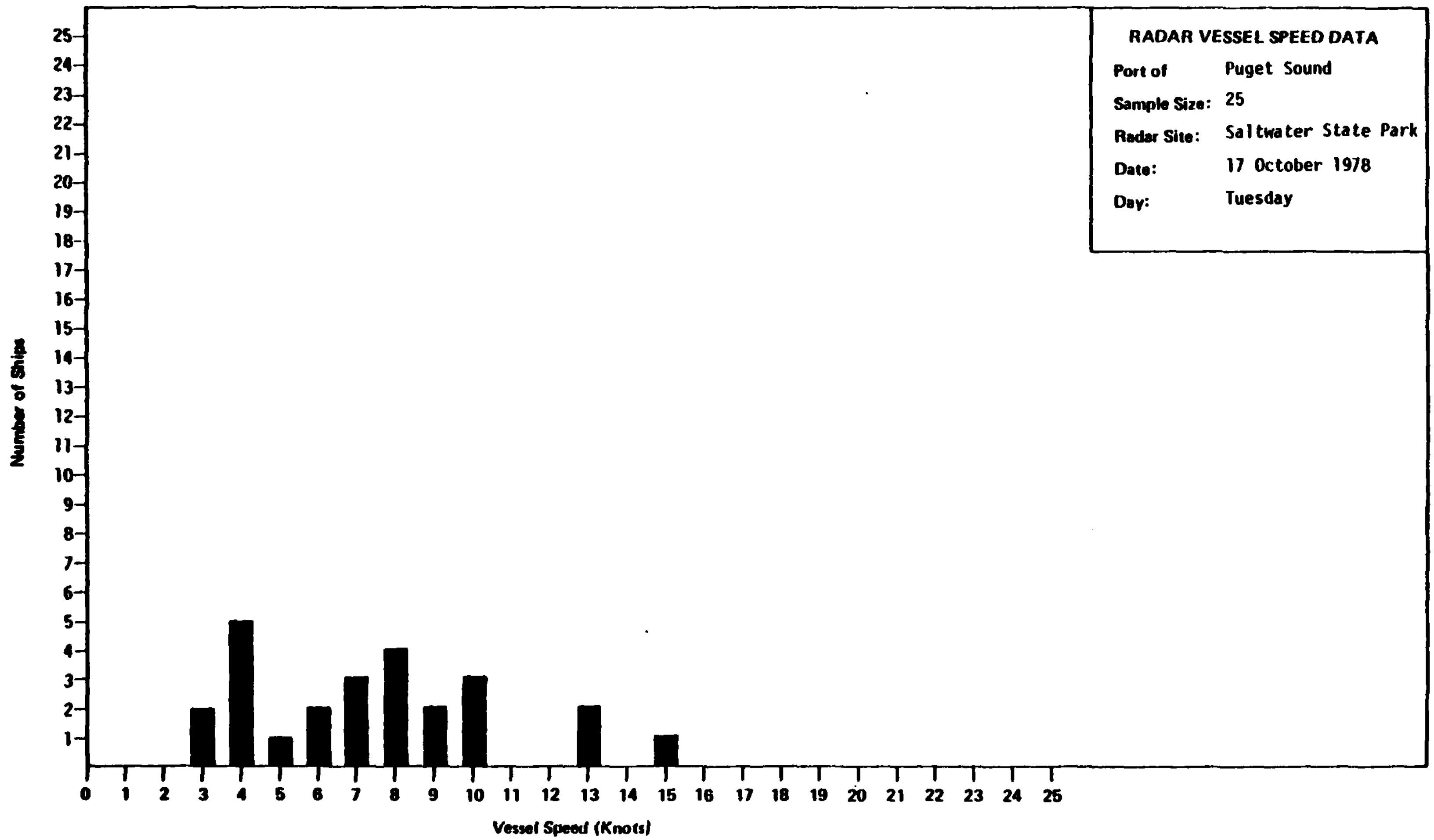

RADAR VESSEL SPEED DATA
Port of Puget Sound
Sample Size: 9
Radar Site: Saltwater State Park
Date: 16 October 1978
Day: Monday
Number of Ships
Vessel Speed (Knots)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

FIGURE 2-10



RADAR VESSEL SPEED DATA
Port of Puget Sound
Sample Size: 25
Radar Site: Saltwater State Park
Date: 17 October 1978
Day: Tuesday
Number of Ships
Vessel Speed (Knots)

FIGURE 2-11

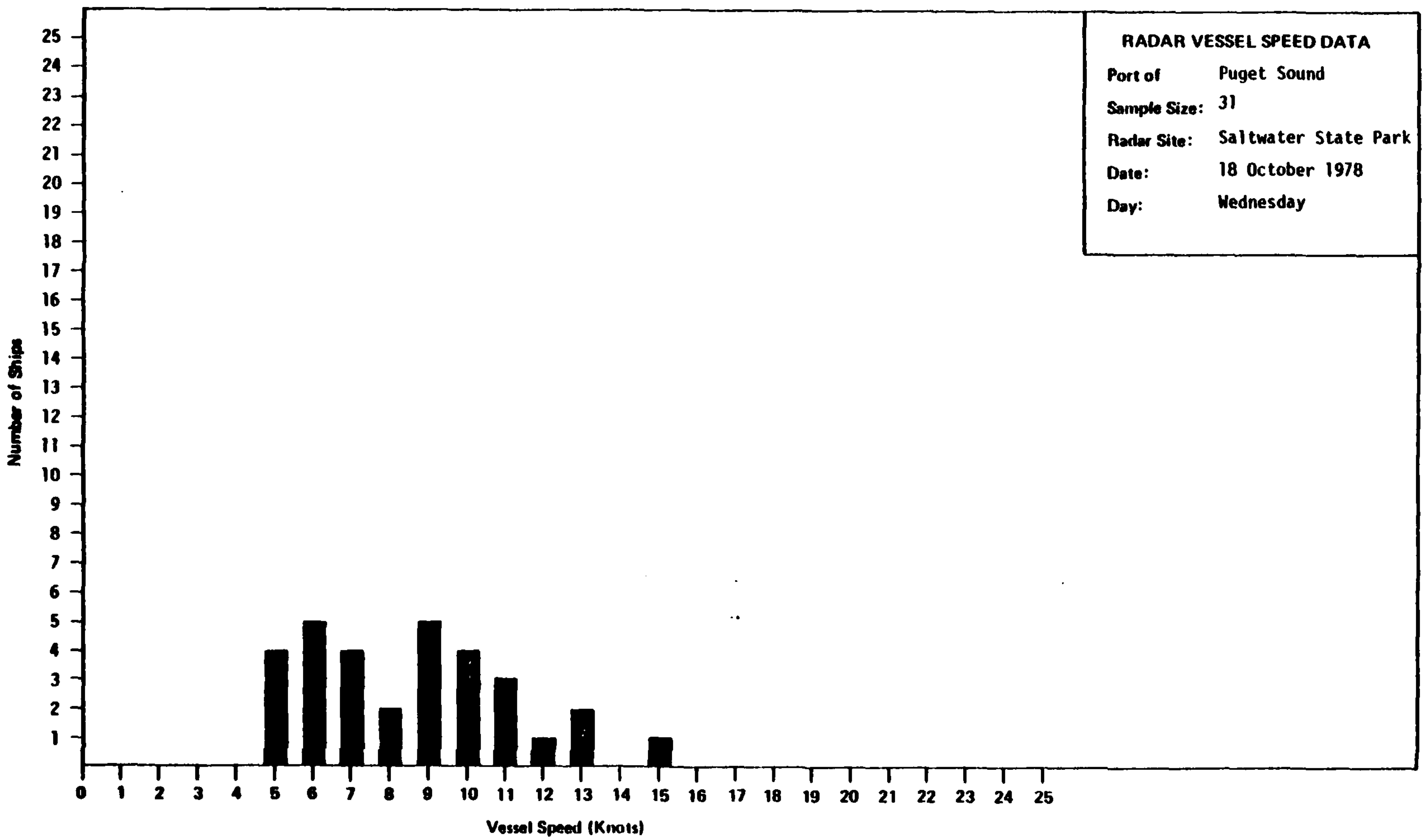
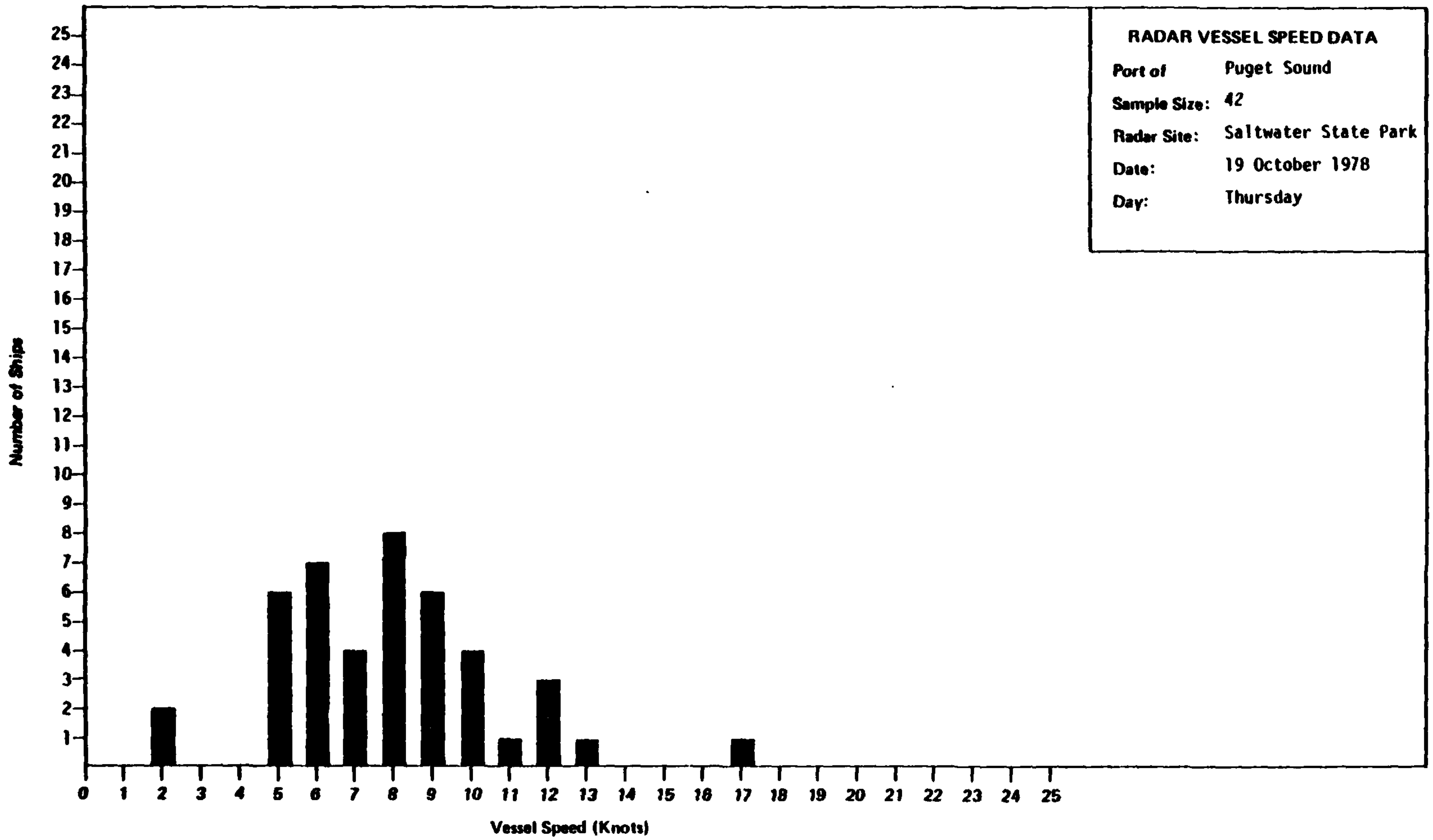

RADAR VESSEL SPEED DATA
Port of Puget Sound
Sample Size: 31
Radar Site: Saltwater State Park
Date: 18 October 1978
Day: Wednesday
Number of Ships
Vessel Speed (Knots)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

FIGURE 2-12



RADAR VESSEL SPEED DATA
Port of Puget Sound
Sample Size: 42
Radar Site: Saltwater State Park
Date: 19 October 1978
Day: Thursday
Number of Ships
Vessel Speed (Knots)

FIGURE 2-13

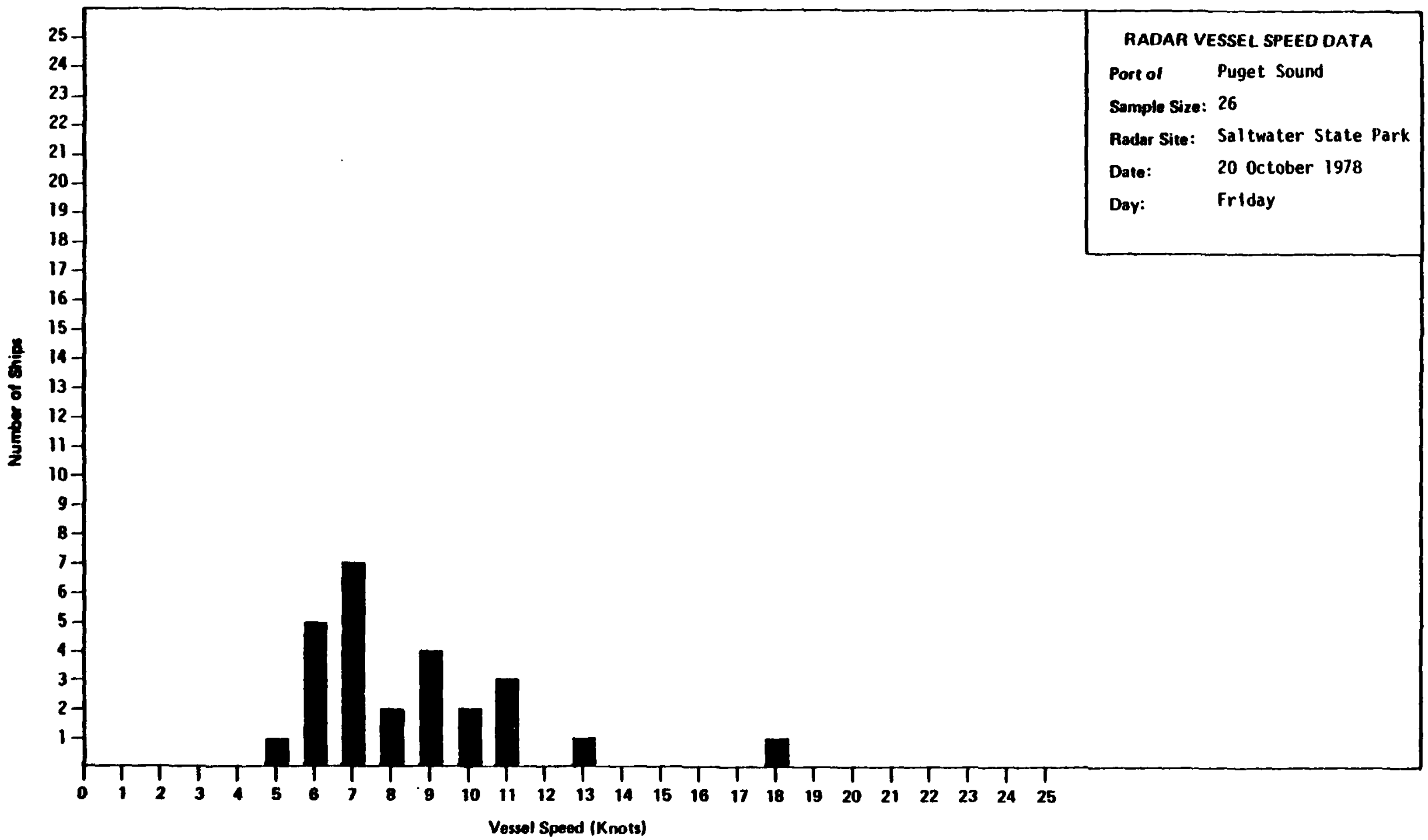

RADAR VESSEL SPEED DATA
Port of Puget Sound
Sample Size: 26
Radar Site: Saltwater State Park
Date: 20 October 1978
Day: Friday
Number of Ships
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Vessel Speed (Knots)

FIGURE 2-14

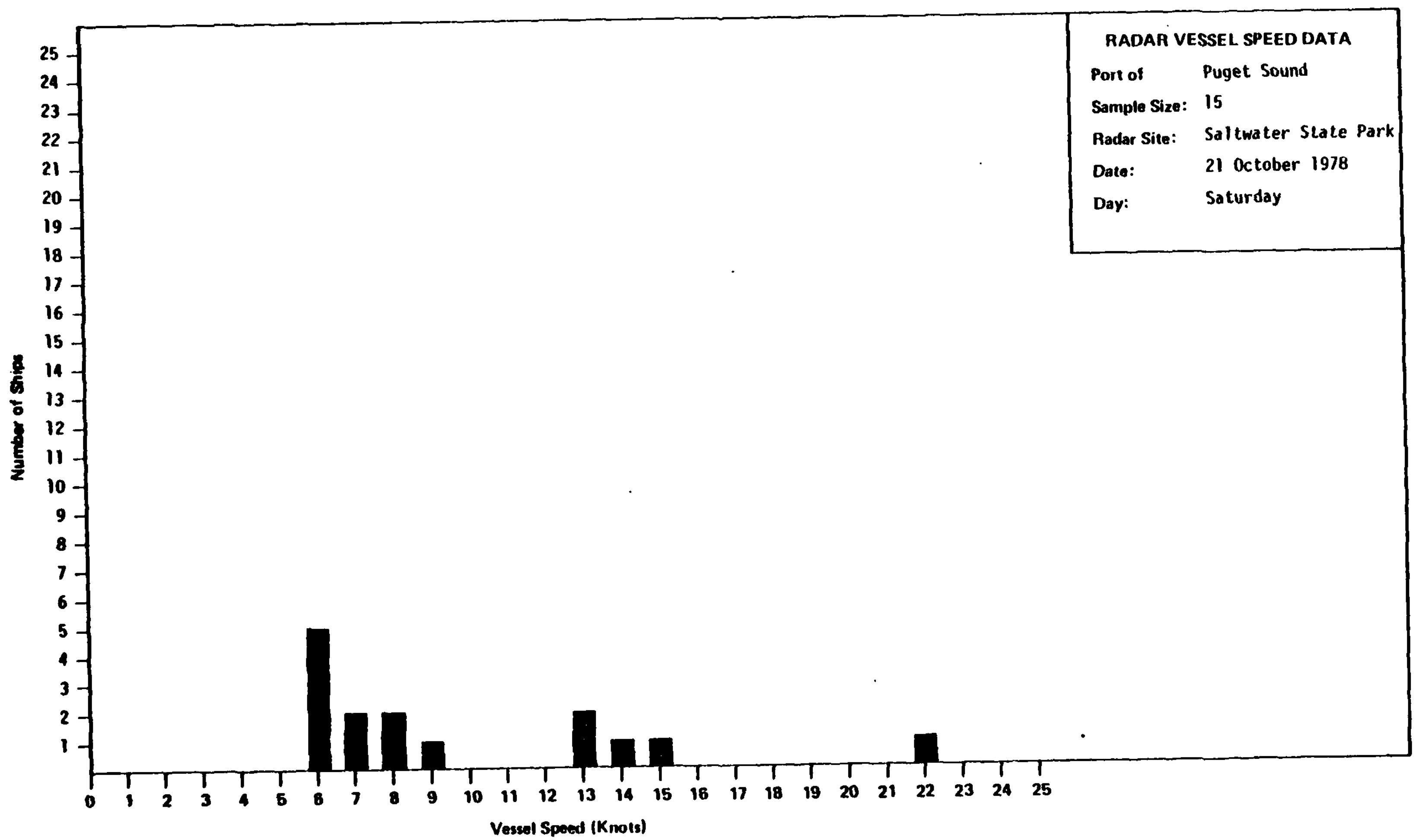

RADAR VESSEL SPEED DATA
Port of Puget Sound
Sample Size: 15
Radar Site: Saltwater State Park
Date: 21 October 1978
Day: Saturday
Number of Ships
Vessel Speed (Knots)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

FIGURE 2-15

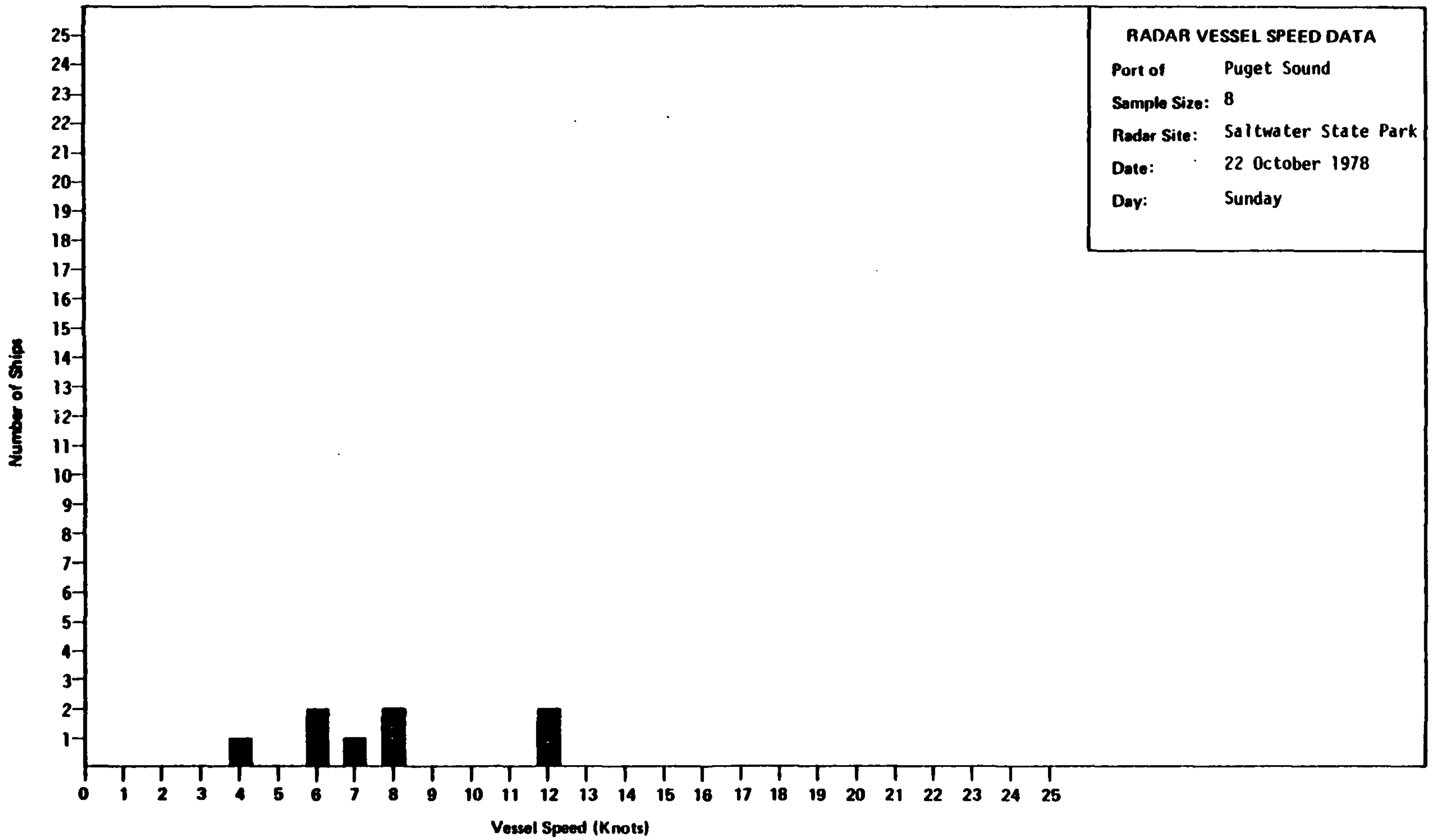

RADAR VESSEL SPEED DATA
Port of Puget Sound
Sample Size: 8
Radar Site: Saltwater State Park
Date: 22 October 1978
Day: Sunday
Number of Ships
Vessel Speed (Knots)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

FIGURE 2-16